Automated Solar Panel Cleaning System

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Abstract: *Solar energy an efficient source of energy for all the forms on the planet. Being a renewable source it has multiple advantages like pollution free, abundant availability hazardless etc. The solar panel works by absorbing the light into solar cells. The power of the solar panel depends on the intensity of sun radiating on the surface. Due to inclined solar panels, they are more liable to build up the dust on it. Our project aims at increasing the efficiency of solar power panel by solving the problem of gathering of dust on the surface of solar panel. Thus, by cleaning the dust on surface of panel it leads to improvement in panel output and overall panel efficiency. The Cleaning Mechanism is used to clean the surface of panel. Also, specific panel detects the obstacle with a Differential Measurement Unit (DMU). It makes the decision from the microcontroller unit to either clean the panel with the cleaning mechanism and roller mechanism or continue to charge the battery with the battery charge.*

Keywords: *Photovoltaic, Solar panel, Cleaning, Efficiency.*

I.   Introduction

At present, there is a great interest towards solving the energy problems faced by the world. This has led to research on alternative energy source that would complement the conventional fossil fuel. Solar is a natural energy source. Solar energy is the energy generated by harnessing the power of the solar radiation. It is the cleanest source of energy whose use can contribute to saving exhaustible energy sources. Such systems are based on a solar collector, designed to collect the sun's energy and to convert it into either electrical power or thermal energy.

The purpose of the project is to design and develop the cleaning solar panels automatically in order to increase the efficiency and energy output from these panels. It is shown that panel efficiency may be reduced by up to 5% to 10% from build up dust particles alone. Adding in other factors such as falling leaves, bird dropping and water streaking, the efficiency of these panels can be further reduced to as much as 10 – 30% [1]. Some studies linked about reduction in output. In the case of a commercial installation, this would be a significantly higher cost. For this project, we focused for more of a smaller scale, as in the case of residential use. There is urgency in improving the efficiency of solar power generation. Current solar panels setups take a major power loss when unwanted obstructions cover the surface of the panels. The obstruction turns the shaded cell into a resistor, causing it to heat up and consume extra power. To address this issue, we are going to design one automated solar panel cleaning system which is very easy to implement. So, stop worrying about climbing the roof top every time.If accumulation of dust on the PV panel reduces its transmittance, then results in the reduction of the power output, therefore resulting in loss of power generation. This particular problem is also responsible for the short life span of many interplanetary exploration missions such as Mars Exploration Mission of Curiosity Rover as the power output from their solar panel reduces over time because of the accumulation of dust [2]. After some particular time period support its vital functions.

Further this problem has also resulted in huge losses for the solar power plant operators which suffer from reduced power output because of frequent dust storms. Most widely used method of cleaning the solar panels is through the manual labor. Apart from being time taking and cumbersome, there is also a risk of damage to the expensive solar panels by the unskilled labor which is involved in this method. The purpose of this project is to develop an automatic self-cleaning mechanism for cleaning the solar panel so that the process can become more reliable and faster, thus increasing the power output of the solar power plant.

II.   Existing Systems

Earlier People were not much aware of the renewable sources and conservation of non-renewable sources but later solar panels were developed for the use of renewable sources. Then systems were developed to clean the panel manually. The conventional energy resources consist of Oil, coal, Gas, Nuclear, Hydro and Solar energy. The consumption of these resources is given below in the form of pie chart as shown in figure [3]-July 2018
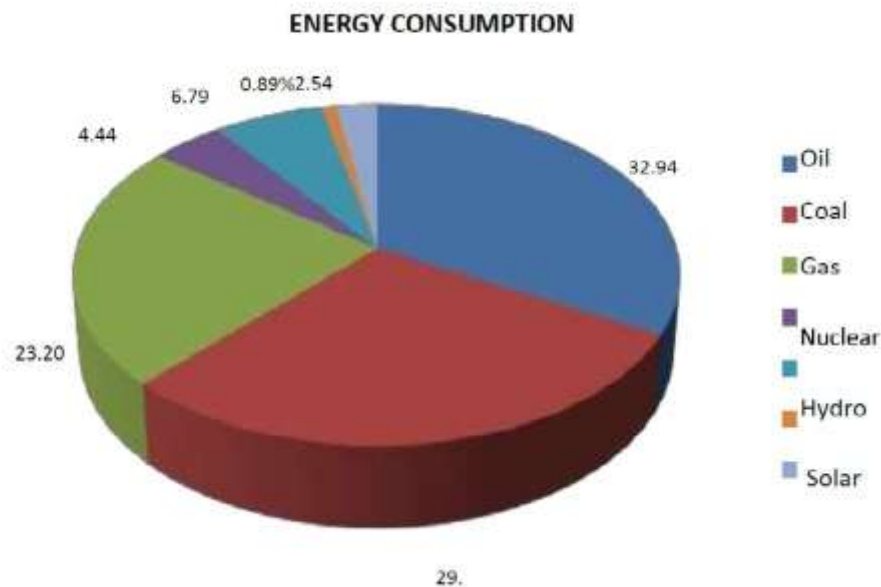
ENERGY CONSUMPTION

Fig 1: Pie Chart of Energy Consumption

India has tremendous scope of generating solar energy. The geographical location of country stands to its benefit for generating solar energy. The reason being India is a tropical country and it receives solar radiation almost throughout the year, which amounts to 3000 hrs. Of sunshine. This is equal to more than 5000 trillion kWh. Almost all parts of India receive 4-7 kWh of solar radiation per square meter. This is equivalent to 2300-3200 sunshine hours per year. States like Maharashtra, Punjab, and Rajasthan etc. have great potential for tapping solar energy due to their location. Since majority of population lives in rural area, there is much scope for solar energy being promoted in these areas [2]. Use of solar energy can reduce the use of firewood and dung cakes by rural household.

Many researchers have worked on this issue, few of them are described here.

K.A. Moharram , M.S. Abd-Elhady, H.A. Kandil , H. El-Sherifet.al. presented a paper "Influence of cleaning using water and surfactants on the performance of photovoltaic panels" in 2013 [4] and it includes that in desert regions the dust affects the solar panels to a great extent and also reduces its efficiency, this paper focuses on cleaning the dust in such regions with the help of minimum water and energy. For this a non-pressurized water system are uses. It was observed that a 14-kW PV power plant was installed in Egypt whose efficiency decreases to 50% after 45 days by using non-pressurized water system, while it remained constant when a mixture of cationic and anionic surfactants was used for cleaning. Thus, using developed systems for cleaning increases efficiency and reduces the amount of water required. Saravanan V. S., Darvekar S. K. "Solar Photovoltaic Panels Cleaning Methods A Review" [5] This paper includes various cleaning methods, such as electrostatic cleaning system, super hyperbolic coating methods, mechanical method, microcontroller based automatic cleaningmethod, self-cleaning nanodimers and various characteristics of dust particles are discussed in this paper. This paper throws light on various cleaning methods for solar photo volatile panels.MontoMani, RohitPillaiet.al.in 2010proposed a system "Impact of dust on solar photovoltaic (PV) performance: Research status, challenges and recommendations" [6] In areas of most oil reserves the PV panels are adopted due to its growing popularity in recent years. PV module installation depending upon efficiency is related to its geographic location. The PV panels are adjusted in such a way to get maximum sun exposure. Dust is the lesser known factor that influence the efficiency of the PV panel. In this paper research and studies related to the impact of dust on the PV solar panels are discussed. Manju B Abdul Bari and Pavan C M July - 2018"Automatic Solar Panel Cleaning System" [7] It includes that the cleaning system designed cleans the module by controlling the Arduino programming. To remove the dust in the PV modules to improving the power efficiency. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. "Smart Solar Tracking and On-Site Photovoltaic Efficiency Measurement System" was proposed by B. A. D. J. C. K. Basnayake, W.A.D.M.Jayathilaka, Y.W.R.Amarasinghe, R.A.Attalage, et.al. In 2016[8] — PV efficiency measuring system and smart solar tracking is used on-site to measure power efficiency of panel and other parameters. At a given location while to

find solar potential PV efficiency is of great importance. The device mentioned is able to measure PV efficiency, ambient temperature, humidity level, light intensity level and temperature of panel. A 24 V DC supply is required for the operation of device. All the data measured is stored in memory card and is transferred to other devices by using Bluetooth. Atmel Mega 2560 controller was used.
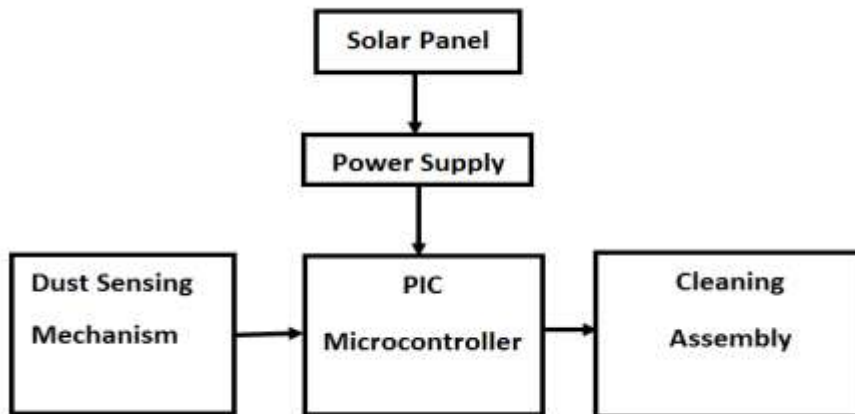
III.   Proposed System

Fig.2: Block Diagram

The solar panel has to be cleaned automatically using cleaning mechanism. It consists of one bracket which is mounted on side of solar panel array having rack and pinion system. It converts rotational motion into translational motion with required torque. The roller mechanism has one roller mounted just above the surface of panel which rotates with particular speed in linear direction. Spray motor is used to supply water which used to perform cleaning using relay driver circuit. Our system chose a PIC18F4520 microcontroller because of its maximum speed, amount of RAM and sufficient number of I/O pins.The cleaning mechanism consists of bracket having one frame structure.By using DC motor, the roller brush rotates with some specific rpm. The roller brush made by soft material which is used to clean the surface of solar panel. It cleans the dust particles present on the panel in downward direction. Gear wheels (Rack and pinion) are used for upward and downward movement of system.

IV.   Methodology

Algorithm:
Step 1: Start
Step 2: Check whether dust particles are present on surface of solar panel or not. If yes then start rack and pinion mechanism for cleaning purpose otherwise go to step 1.
Step 3: Start rack and pinion mechanism
Step 4: Start spray motor
Step 5: Start DC motor
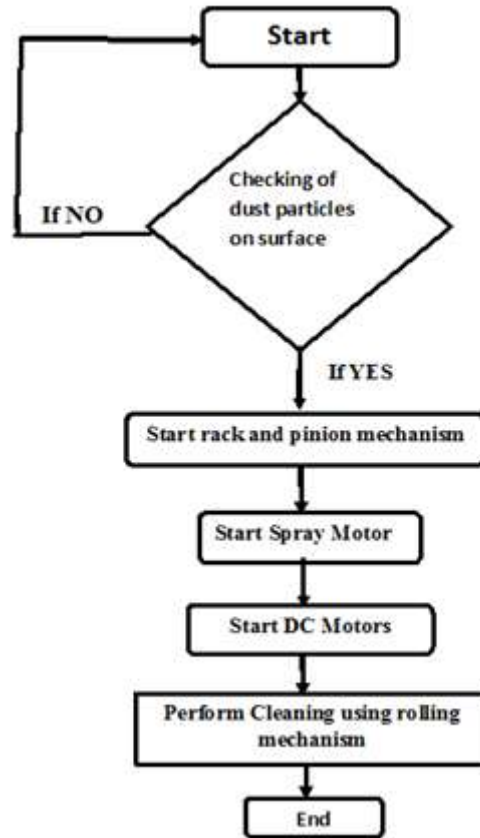**Step 6:** Perform rolling action
Step 7: End

Fig.3: Flowchart of Cleaning System

V.   Results and Discussion

The cleaning mechanism consist of bracket having one frame structure. The rack and pinion gear mounted on the two sides of the panel which is used to convert rotational motion into translational motion. By using DC motor, the roller brush rotates with some specific rpm. The roller brush made by soft material which is used to clean the surface of solar panel. It cleans the dust particles present on the panel in downward direction. Gear wheels (Rack and pinion) are used for upward and downward movement of system. Our project has few limitations such as, rolling brush which consists of cloth would need to be changed periodically, and it is ineffective for sticky dust and cannot clean the dust at the corners of the panel.
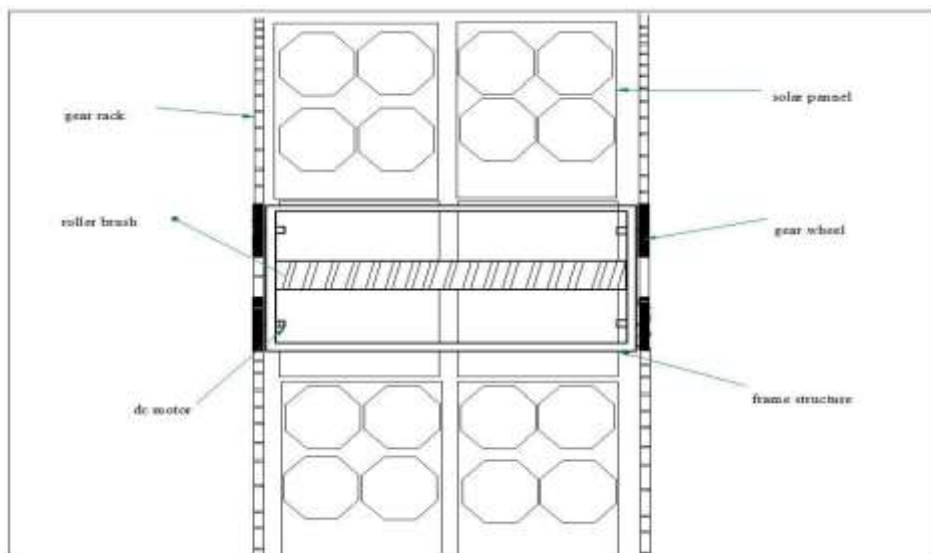

Fig.4: Use of Roller Mechanism for cleaning purpose

From the below two figures, we can see that cleaning assembly is working properly.

Fig.5 a) Before Cleaning   **Fig.5 b) After Cleaning**

VI.   Conclusion

Existing solar panel cleaning systems mainly focus on the large arrays and mostly not suitable for small size arrays. Our system is suitable for such PV arrays which can be easily installed for roof top solar panels also. It is verified through experimentation that the system works well for different types of dust. Through the proper cleaning of PV panel the efficiency of system increases and hence it can yield more power. The system can further be extended for a large size solar systems with few modifications.

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